

PROBLEMS OF TECHNICAL EDUCATION AND LACK OF STUDENTS AT CZECH TECHNICAL UNIVERSITIES

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Abstract. If the Czech Republic is to maintain its competitiveness with advanced economies and a stable economic growth, it cannot do without one of the most important sectors of the national economy - the construction industry. The support of national construction contracts, complying with building legislation, the favorable conditions for the operation of construction companies, a support for BIM must become the state's priority; BIM is currently considered as a revolution in the construction industry. But the construction, as well as other industrial production, cannot be done without technically educated people. Although the demand for technical graduates has long outpaced the supply, the technical universities are unable to meet the needs of the labor market. In addition, the number of college technicians is declining each year. It is estimated that 70,000 workers are missing today in the Czech industry. The lack of technicians may have a very negative impact on GDP and the growth of the Czech economy. There are a number of reasons to not initiate the process of implementing BIM yet, but if the current trend is not reversed as soon as possible, the Czech Republic will become less competitive in the global economy and dependent on foreign knowledge and foreign technology.

Keywords: BIM, construction, industry, labor market, technical education, university.

Introduction

The construction industry is one of the most important sectors of the economy, both in terms of GDP and employment. In Europe, the construction industry is one of the largest in the economy - it employs about 12 million people and accounts for almost 10 % of GDP [1]. Therefore, the construction output is considered to be one of the important indicators of the economic development.

The construction industry is practically the only sector in the current Czech economy, through which the state (regions, municipalities) can directly (with the public investment and the construction contracts) promote the dynamics of the economic growth and employment. Investment only creates new jobs. Construction work (construction of new buildings, roads, etc.) stimulates GDP and, as one of the main factors, contributes to the growth of the whole economy.

Through the so-called multiplier effect, the building industry has an impact on the demand for products of the other sectors and services. It is estimated that the value of the multiplier effect in the Czech Republic currently stands at 3.2 to 3.5, which means that the reduction in the number of workers in the building industry by one worker will cause a loss of employment of 3.2 to 3.5 employees in other sectors. From this point of view, the reduction of public investment in construction works has a very negative impact on unemployment and the related performance of the whole economy.

With a lack of investment, especially the public contracts, the Czech construction has been struggling for several years. According to the data from the Eurostat, the Czech construction sector declined by 5.8 year-on-year in 2016, its performance was the eighth worst of all 28 countries of the EU. A drop of 9.6 registered the building industry in Lithuania, a similarly unfavorable result - 10.9 Slovakia, the worst was Hungary, Latvia, Slovenia and Bulgaria with almost a fifth decline [2] (See Table 1).

Construction output in the year 2017 increased by 3.5 year-on-year after working-day adjustment, excluding netting, by 1.7 %. The year 2017 was less than two business days compared to the previous year. Construction output increased year-on-year by 5.0 (contribution + 3.4 pp), while construction engineering recorded a year-on-year decrease in construction output by 5.7 (contribution -1.7 pp). However, with the lack of investment, especially public contracts, the Czech construction industry is still struggling.

Many design and construction companies are now looking to hire staff with BIM- based knowledge in response to meeting the growing demands of the profession with belief that graduates with knowledge of BIM need more practice [3]. In spite of knowing that 45 % of the engineers are aware of BIM, many universities are still not initiated the process of implementing BIM.

Table 1

Construction developments in the EU countries in 2016: EU-28 Construction, the annual rate of change 2005 - 2017, calendar adjusted data

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU-28	1.7	3.8	3.4	-1.9	-7.7	-2.3	-0.1	-5.5	-1.7	2.7	1.1	2.5	3.8
EA-19	2.1	3.5	3.0	-2.8	-6.5	-5.2	-1.4	-5.3	-2.3	0.6	-0.7	2.6	2.6
Belgium	0.5	3.7	2.0	0.8	-3.2	-1.7	5.3	-0.9	-2.2	-0.7	-2.4	0.3	0.7
Bulgaria	31.8	24.1	27.4	12.3	-14.4	-14.7	-12.8	-1.2	-3.4	6.8	11.1	-16.3	4.7
Czech Republic	5.2	6.3	7.1	-0.2	-0.9	-7.6	-3.4	-7.3	-6.8	4.2	7.0	-5.8	3.5
Denmark	5.5	6.0	2.6	-0.1	-11.5	-6.4	3.3	0.8	-0.5	4.4	4.4	4.6	4.3
Germany	-5.3	6.1	2.9	-0.3	-0.1	-0.9	7.3	0.0	-0.1	2.9	-2.2	5.6	3.2
Estonia	22.3	26.9	13.6	-13.1	-29.9	-8.6	27.3	16.6	-0.1	-2.1	-3.5	4.6	17.7
Ireland	9.9	3.9	-13.5	-29.2	-36.9	-29.7	-16.7	-2.4	11.3	8.2	7.9	18.3	17.4
Greece	-38.8	3.3	14.3	7.8	-17.1	-29.6	-41.3	-33.5	-8.2	15.5	3.1	22.9	-14.6
Spain	10.9	2.2	-4.3	-16.3	-11.2	-20.4	-19.8	-5.4	1.5	17.4	1.7	5.1	-1.7
France	3.0	2.5	4.4	-1.9	-5.8	-2.4	-1.8	-5.1	0.6	-2.6	-2.2	-0.2	3.0
Croatia	-1.1	10.7	4.3	12.9	-5.8	-17.3	-11.3	-12.2	-4.6	-7.3	-1.0	2.4	1.5
Italy	1.0	3.8	6.4	-0.8	-11.5	-3.5	-4.4	-13.4	-10.3	-6.7	-1.9	-0.3	0.3
Cyprus	2.8	4.1	6.8	2.3	-10.6	-8.0	-6.8	-21.1	-18.9	-21.7	0.2	9.0	:
Latvia	15.2	13.3	13.7	-2.9	-34.9	-23.5	12.4	14.4	7.3	7.9	-1.2	-17.8	19.3
Lithuania	9.4	21.4	22.4	4.3	-48.3	-7.6	22.4	-7.2	11.7	16.6	-3.6	-9.6	9.6
Luxembourg	-1.0	2.3	2.8	-1.1	0.0	0.2	1.4	-3.8	-4.2	4.2	-1.5	3.7	0.4
Hungary	15.9	-0.8	-14.3	-5.1	-4.3	-10.4	-8.0	-6.6	8.5	13.6	3.0	-18.9	29.6
Malta	18.6	4.8	8.7	7.4	3.4	1.7	4.5	1.7	1.8	2.5	15.9	-3.8	13.0
Netherlands	5.1	3.3	6.2	3.9	-4.6	-10.7	0.5	-7.7	-5.1	4.2	8.2	7.0	6.5
Austria	4.9	5.9	3.9	-0.8	-1.8	-4.1	1.9	3.5	0.4	-1.7	-1.7	2.3	5.8
Poland	9.2	16.6	16.2	9.7	4.1	3.6	16.1	-5.2	-9.9	4.0	0.2	-14.5	14.2
Portugal	-1.4	-6.3	-3.8	-4.6	-10.4	-11.7	-12.7	-16.1	-16.2	-9.6	-3.1	-3.8	2.2
Romania	7.0	15.7	33.0	27.0	-15.2	-13.5	3.1	1.8	-0.7	-6.6	10.3	-4.4	-5.1
Slovenia	2.1	15.6	18.5	15.5	-21.0	-17.0	-24.8	-16.8	-2.6	19.5	-8.2	-17.7	17.7
Slovakia	14.0	15.8	5.6	11.7	-11.2	-12.0	6.0	-12.0	-5.2	-4.5	18.1	-10.9	3.6
Finland	4.4	7.7	10.9	3.3	-12.6	11.5	8.0	-0.9	-3.2	0.4	5.7	5.7	5.4
Sweden	0.0	11.5	11.4	-1.4	-12.2	8.1	2.5	-6.3	-3.3	1.0	8.0	9.3	7.5
United Kingdom	-0.5	1.4	2.3	-1.2	-11.7	7.2	2.2	-6.9	1.5	9.0	4.4	3.9	5.1
Norway	8.3	6.1	6.0	1.4	-8.7	0.0	3.0	7.5	6.3	4.6	1.5	3.6	4.4
Switzerland	3.4	3.7	0.5	2.1	0.7	1.2	2.8	-0.7	1.5	1.6	-3.8	0.1	3.2
Montenegro	5.6	42.3	1.4	19.4	-18.4	-0.3	18.3	7.8	40.0	34.9	20.3	47.7	42.0
Former Yugoslav													
Republic of Macedonia	:	:	:	20.4	7.5	16.7	28.4	8.0	43.3	-3.4	40.8	8.0	-25.9
Albania	:	:	:	:	:	:	:	:	:	:	:	:	:
Serbia	13.8	10.0	21.9	4.0	-18.3	-7.8	18.8	0.3	-20.7	2.9	21.1	7.3	6.3
Turkey	:	:	:	:	:	:	:	:	:	:	:	:	:
Bosnia and Herzegovina	:	5.4	13.0	8.8	-7.7	-12.4	-5.6	-2.9	-2.5	7.2	-3.2	-1.0	-2.3

Source: Eurostat (online data code: sts_copr_a), 2016 [4], : –not available

The slow construction industry is the biggest break of the Czech economy. A slow approval procedure and a long construction permit are the leading causes. Getting a building permit for larger projects takes several years. In the global comparisons, the Czech Republic has been placed annually in unfriendly places. Improving of the situation is expected with an amendment to the Building Law, which should shorten the process.

Materials and methods

BIM as a competitive advantage

In order to remain competitive on the market, construction companies must ensure they keep up with the latest technical and technological developments. In the field of building construction, these are, for example, technologies and materials for the construction and operation of so-called green or smart buildings, while in the transportation infrastructure of the construction industry this can include transport infrastructure with minimal negative impacts on the environment.

As the practice confirms, usage of the BIM for processing the construction work is a significant competitive advantage for businesses. They have gained new tools for visualization, coordination, early analysis of solutions, and more.

In some countries (the UK, Spain, Denmark, Finland, Norway, the Netherlands, ...), BIM has become an obligatory part of industry standards for building design. The use of BIM also becomes an

obligation in the implementation of over-the-threshold public construction contracts (so-called BIM mandate). For the EU Member States, recommendations for the modernization of public procurement rules in the construction and transport sector [5] of January.

BIM was defined by [6] as “a verb or adjective phrase to describe tools, processes, and technologies that are facilitated by digital machine-readable documentation about a building, its performance, its planning, construction, and later its operation.”

BIM's application to Czech construction is a solution to how businesses can streamline their workflows and shorten the construction time. Implementation of BIM leads to increased efficiency of work of all stakeholders in the construction work, i.e., designers, architects, statics and construction engineers. Expensive 3D models make it easy to communicate with investors, developers or building managers. Most problems and ambiguities can be solved with the use of BIM tools at the very start of collaboration, when all stakeholders are involved in designing. All parties have immediate feedback, and the whole process leading to construction accelerates. BIM is a tool that enables qualified technicians to execute building projects more accurately, faster, more economically and on time.

A skilled labor force has always been and is still a pillar of the Czech economy. For construction, this is double. A major problem today is the age of workers in the development of manual work as well as managers, the period is steadily rising. Implementation of the BIM technology requires a change of mindset, working with the intelligent 3D BIM model puts higher demands on software and hardware than with traditional 2D CAD procedures. Implementation of BIM requires young, technically educated people, who are interested in new technologies, who want to develop professionally and who want to try new things. Companies have problems to find such people.

Results and discussion

Issues and barriers in adoption of BIM

Technical universities are facing misconceptions about the reality of BIM and its overall application, which is considered as the biggest hurdle in its adoption. In addition, to the lack of availability of people with the knowledge to teach it as a new technology, not only to training students in BIM software. Also, poverty of BIM resources and learning of BIM are not yet identified as part of the teaching plan at so many of these universities [7].

Lack of Students at Technical Schools

Currently, the situation in the Czech Republic is unfavorable. There are people lacking across all technical disciplines on the labor market, as well as in technical schools (vocational schools, secondary professional schools, and technical universities). The main cause is the demographic development, which results in the population decline of today's young generation, in the non-conceptual system of education in the Czech Republic, the high number of private schools and poorly defined limits of the number of accepted applicants. Thanks to all these factors, the number of secondary school graduates in 2008 coincided with the number of available capacities at universities. Due to the current system of funding for universities, it was in their interest to fill every vacancy. Over the past decade, universities have received nearly 70 % of all graduates. This increase is evident from Fig. 1.

At technical universities, where the candidates' interest in the long term is significantly lower than in the case of the humanities, admission tests have become almost a formal matter. Without the need for more effort, without selection and limitations at the technical universities, nearly all of the applicants are registered.

The largest increase in university students in the Czech Republic is apparent from 2001 to 2010, almost doubled, and followed by the annual declines. Decreases in the number of students in various fields are recorded in Table 2.

Since 2010, the number of students of technical sciences, manufacturing, and construction has been decreasing every year. This corresponds to the development of the total number of university students (Bachelor, Master and Doctoral Studies) in the Czech Republic. While in 2010 about 86

thousand students studied technical sciences at Czech universities (public and private), in 2017 the number of students dropped to about 65 thousand (see Table 2).

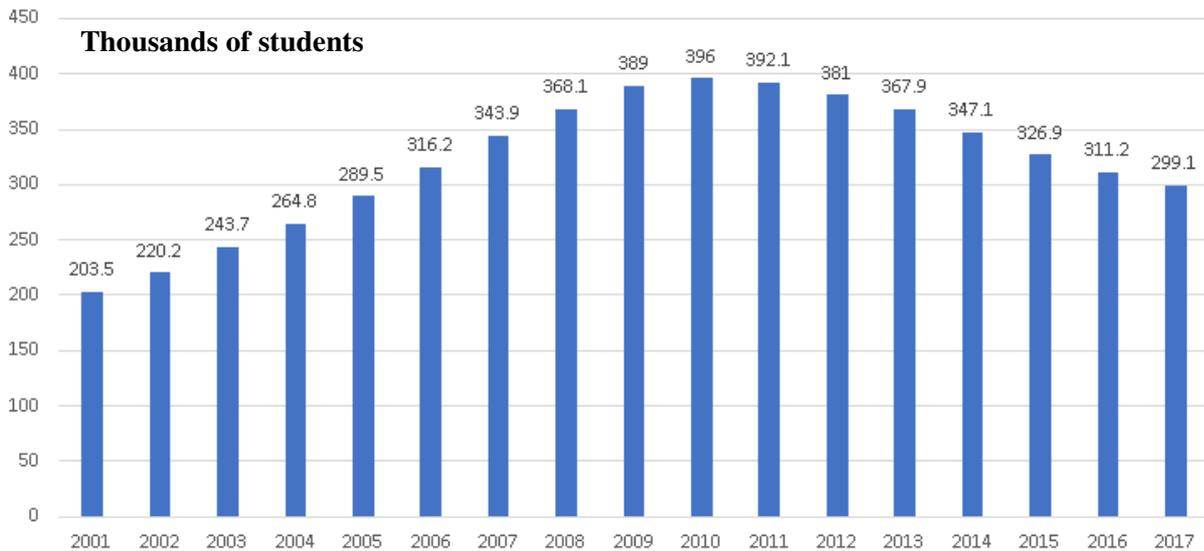


Fig. 1. Students at universities in the Czech Republic, Source: MSMT (<http://www.msmt.cz/vzdelavani/skolstvi-v-cr/statistika-skolstvi/data-o-studentech-poprve-zapsanych-a-absolventech-vysokych>) [8]

Table 2

Students in the Czech Republic by field of education (2001-2017)

Universities in CR	2010	2011	2012	2013	2014	2015	2016	2017
Science	32 064	32 541	32 508	31 968	31 312	29 854	28 358	27 550
Technical sciences	86 579	85 175	83 286	82 351	77 934	73 236	69 174	65 352
Agriculture and veterinary	14 990	15 027	15 417	14 445	13 898	13 469	13 482	13 218
Health and social cre	28 734	29 850	30 335	30 837	30 604	30 988	31 198	31 042
Humanities and social sciences	67 296	67 551	65 851	63 534	59 503	56 196	53 167	50 352
Economic sciences	99 083	96 523	91 602	85 221	76 423	69 449	64 510	60 559
Law	16 162	15 532	14 150	13 890	13 532	13 398	13 276	13 618
Pedagogy, social sciences	48 403	46 770	43 591	41 065	38 915	34 734	32 868	31 722
Culture and art	10 236	10 311	10 281	10 004	9 828	9 760	9 343	9 355

Source: MSMT (<http://www.msmt.cz/vzdelavani/skolstvi-v-cr/statistika-skolstvi/data-o-studentech-poprve-zapsanych-a-absolventech-vysokych>) [8]

As it can be seen from Table 1, the highest number of university students enrolled in 2010 in the fields of economic and technical sciences. These branches show the biggest drops of students in the following years.

Lack of Czech students at technical universities is increasingly being replaced by students from abroad. Most often they are students from Slovakia, Ukraine or Russia. Their share in the total number of students of technical sciences, manufacturing, and construction increased significantly and continuously from 2001 to 2017, from 2.6 % in 2001 to 11.4 % in 2017.

In order to mandate the BIM technology, it is critical to enhance the professionals' skills within the construction industry by integrating BIM early in the curriculum [9]. There is thus an increasing need for students, professionals and engineers to not only know the big important role the BIM plays in the AEC industry, but more importantly, to be aware of the necessity to be trained in adopting BIM into their work environment.

Conclusions

1. A similar trend as in the Czech Republic can be observed throughout Europe. Only 15 % of young Europeans head into technically oriented secondary education. Similarly, the interest in the study of technical disciplines in the US is long-term low.

2. The opposite trend is shown, for example, by China and Indonesia, where about 3/5 students are devoted to science and technique.
3. If this trend does not change in the Czech Republic, if we do not begin to engage more intensively students and graduates in the fields of technical sciences, manufacturing, and construction, the Czech Republic will become heavily dependent on foreign knowledge and foreign technologies.
4. At the time, when we are talking about knowledge society, it is a loss of competitiveness on an international scale. These are the fields that are the most important for science and technology in terms of human resources.

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References

- [1] Ahmed S. et al. Analyzing the Change Orders Impact on Building Projects. *Journal of Engineering and Applied Sciences*. 2016, 2016 (11) (7), pp. 1532-1537. ISSN 1816-949X. [online] [19.03.2018] Available from: <http://medwelljournals.com/>
- [2] Ceske stavebnictvi bylo loni v EU osme nejhorsi (Eurostat: Czech construction was last year in the top eighth in EU) [online] [19.03.2018] Available at: <http://www.ceskenoviny.cz/zpravy/eurostat-ceske-stavebnictvi-bylo-loni-v-eu-osme-nejhorsi/1463977> (In Czech)
- [3] Sabongi, F.J. The Integration of BIM in the Undergraduate Curriculum: an analysis of undergraduate courses. Proceedings of the 45th ASC Annual Conference, Gainesville, Florida, April 1-4, 2009.
- [4] Eurostat/statistics – explained, 2017. ISSN: 2443-8219 [online] [19.03.2018] Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:EU-28_Construction,_annual_rate_of_change_2005_-_2017,_calendar_adjusted_data.png.
- [5] Vysoké školy (Universities) [online] [19.03.2018] Available at: <http://www.msmt.cz/ministerstvo/odkazy/vysoke-skoly> (In Czech)
- [6] Ahmed S., Selim O. Way to BIM. Book, 2018. [online] [19.03.2018] Available in Arabic at: <http://bimarabia.com/>
- [7] Eastman, C., Teicholz, P., Sacks R., and Liston, K. “BIM Handbook: A guide to BIM for Owners,” Managers, Designers, Engineers and Contractors, Wiley publication, 2008, ISBN 978-0-47018528-5.
- [8] Kymmell W. “Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations”, United States: McGraw – Hill Construction Series, 2008.
- [9] The Ministry of Education, Youth and Sports. Available at: <http://www.msmt.cz/vzdelavani/skolstvi-v-cr/statistika-skolstvi/data-o-studentech-poprve-zapsanych-a-absolventech-vysokych>, 2018 (In Czech)
- [10] RAIC (2007) Building Information Modeling (BIM), RAIC Practice Builder, Royal Architectural Institute of Canada